The Essential to Every Project

1. Data Mining
2. Methods Consulting
3. Field Explorations
4. Laboratory Testing
5. Characterize and Report
GEOHAZARDS

• Landslide
• Rockfall
• Underground Mine Subsidence
• Karst Subsidence

Geotechnical Site Characterization
Site Characterization | The *Essential* Start to Every Project
Geotechnical Engineering

Field Exploration

Laboratory Testing

Construction Observation

Analysis and Design
Geotechnical Engineering

Field Exploration

Laboratory Testing

Geotechnical Site Characterization
Differing Subsurface Conditions
Differing Subsurface Conditions

Cohesion, c

\[ \sigma_3 \quad \sigma_d \quad \sigma_1 \]

Angle of Internal Friction, \( \phi \)

80%
Geotechnical Site Characterization

Field Exploration

Laboratory Testing
4 Segments of Geotechnical Engineering

1. Field Exploration
2. Geotechnical Site Characterization
3. Laboratory Testing
5 Steps of ...

1. Data Mining
2. Methods
3. Consulting
4. Geotechnical Site Characterization
5. Characterize and Report

Field Exploration Laboratory Testing
**Geotechnical Site Characterization**

**STEP 1 - DATA MINING**

1. Data Mining
2. Methods Consulting
3. Field Explorations
4. Laboratory Testing
5. Characterize and Report
Valuable Historic Data
Activated for Useful Access
1 Data Mining
2 Methods Consulting
3 Field Explorations
4 Laboratory Testing
5 Characterize and Report

STEP 1 - DATA MINING

Valuable Historic Data
Activated for Useful Access
Enhanced with GIS Information
**Step 1 - Data Mining**

1. Data Mining
2. Methods Consulting
3. Field Explorations
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Valuable Historic Data
Activated for Useful Access
Enhanced with GIS Information
Allows Characterization & Preliminary Evaluation
WHAT ARE THE EXPECTED GEOTECHNICAL CONDITIONS?
STEP 2 - METHODS CONSULTING

1. Data Mining
2. Methods Consulting
3. Field Explorations
4. Laboratory Testing
5. Characterize and Report

Geotechnical Site Characterization

- Geotechnical Engineers
- Drillers
- Geophysicists
- In-Situ Testing
- Laboratory Testing
- Geologists

Work Planning
- Options
- Sequence
- Interaction
STEP 3 - FIELD EXPLORATION

1. Data Mining
2. Methods Consulting
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Geotechnical Site Characterization
**STEP 3 - FIELD EXPLORATION**

1. Data Mining
2. Methods Consulting
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**Geotechnical Site Characterization**

- **Drill/Sample**
- **In-Situ Testing**
- **Geophysical**
**STEP 3 – FIELD EXPLORATION**

1. Data Mining
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Geotechnical Site Characterization
STEP 3 - FIELD EXPLORATION

Geotechnical Site Characterization
Current Exploration Capabilities

Exploration Resource Centers

<table>
<thead>
<tr>
<th>Rigs</th>
<th>Exist</th>
<th>Planned</th>
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<tbody>
<tr>
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<td>2</td>
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<tr>
<td>Simco</td>
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</table>

(Number indicates number of units)
STEP 3 - FIELD EXPLORATION

Geotechnical Site Characterization

- **SPT** - Standard Penetration Test
- **CPT** - Cone Penetration Test
- **DMT** - Flat Plate Dilatometer Test
- **PMT** - Prebored Pressuremeter Test
- **VST** - Vane Shear Test
Standard Penetration Test

- The tried and proven” test
- Around for 100+ years
- In-situ Test (N value) but yields disturbed sample
- Intended for granular deposits (where sampling is difficult)
- Overused but state of the practice…
STEP 3 - FIELD EXPLORATION

1. Data Mining
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Geotechnical Site Characterization

- SPT (Standard Penetration Test)
- CPT (Cone Penetration Test)
- DMT (Deep Material Testing)
- PMT (Prebored Pressuremeter Test)
- VST (Vane Shear Test)
Cone Penetration Testing
Cone Penetration Testing

A 10 sq cm (1.4 in. dia.) probe with a 60° conical tip is pushed into the soil at a rate of 2 cm/sec (4 ft/min).

Continuous data collection transmitted real-time on site.

Tip and sleeve Load Cells

Pore pressure Transducer

Tip Resistance, $q_c$

Sleeve Resistance, $f_s$

Pore Pressure, $u$
Cone Penetration Testing

Using empirical correlations of the tip and sleeve resistance and pore water pressure data estimates of many soil parameters can be developed.

A few examples include:
- Undrained Shear Strength (of cohesive soils)
- Friction Angle (of cohesionless soils)
- Overconsolidation Ratio
- Hydraulic Conductivity

Empirical correlations are also used to predict soil behavior type. The following slide illustrates this process.
Geotechnical Site Characterization

The Essential Start to Every Project

- High Plasticity Clays
- Low Plasticity Clays
- Silts and Sandy Silts
- Sands

Cone resistance $q_c$ (MPa)

Friction ratio (%)
1. Data Mining
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Geotechnical Site Characterization
Geophysical Services

Seismic

Refraction, Reflection, MASW, ReMi, Downhole/Crosshole
Geophysical Services

Ground-Penetrating Radar (GPR)
Time/Frequency Domain Electromagnetic Magnetics
Geophysical Services

Resistivity

Electrical Resistivity Tomography (2D and 3D)
Induced Polarization and Spontaneous Potential
Wenner 4-pin to 1000’ A-spacings
Fall of Potential
STEP 4 - LABORATORY TESTING

Geotechnical Site Characterization
**STEP 4 - LABORATORY TESTING**

Geotechnical Site Characterization
STEP 5 - CHARACTERIZE AND REPORT

Geotechnical Site Characterization

1. Data Mining
2. Methods Consulting
3. Field Explorations
4. Laboratory Testing
5. Characterize and Report

Terracon (Data)
- Field
- Laboratory

Client
- Directives
- Information
GEOTECHNICAL SITE CHARACTERIZATION SERVICES

1. Data Mining
2. Methods Consulting
3. Field Explorations
4. Laboratory Testing
5. Characterize and Report

Drill/Sample
In-Situ Testing
Laboratory Testing
Geophysical
**Geotechnical Site Characterization Services**

1. Data Mining
2. Field Explorations
3. Laboratory Testing
4. Characterize and Report

**Geotechnical Site Characterization Scoping Document**

**FIELD**

**IN-SITU**

LABORATORY AND SITE VISUALIZATION FROM ONE DATABASE

**ADDITIONAL IMAGES**
Like most professions, geotechnical engineering has benefited immensely from the personal computer revolution. Today, better computing capabilities allows engineers to accurately calculate in seconds what used to take days or weeks to complete.

As the profession evolves to take advantage of these advancements, we are limited only by our ability to imagine the ways in which we can apply computing technology to answer the difficult questions that arise when structure meets soil. Now, the semi-infinite, homogeneous, isotropic half-space our professors taught us to consider for purposes of simplicity can be tossed to the side to allow numerical modeling calculations to account for the results of any variation that we choose to add to the model.

But a danger lurks beneath:

Calculations are only as reliable as the site characterization work that was performed. Site characterization precedes geotechnical engineering, analysis, and design and allows us to better understand the site. Its soil, rock (if present), and groundwater conditions. We must understand the soil and rock properties to a degree of accuracy and precision that is compatible with the numerical analyses that will be performed.

Consider the standard penetration test. This is a time-honored way of determining foundation properties and settlements by hitting a 10-pound hammer 15 times and dropping it on steel drill rods to pound a cone into the soil. As we drop this hammer, we count the number...